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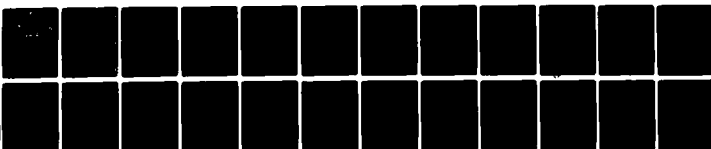
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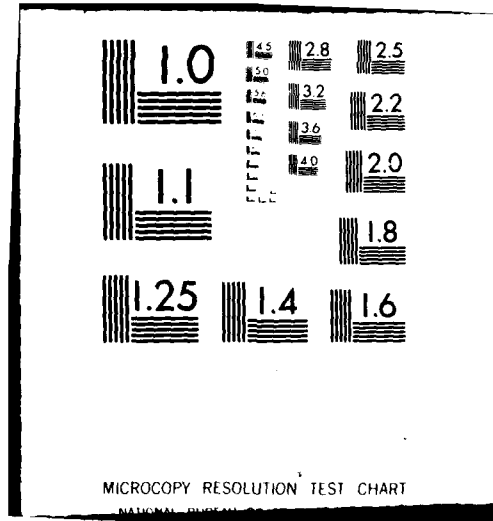
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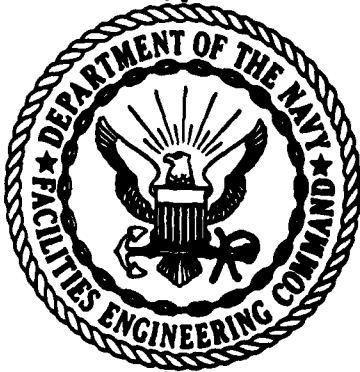


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CONCRETE STRUCTURES

DESIGN MANUAL 2.4

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ABSTRACT

Basic criteria for the design of concrete structures, except floating structures and pavements, are presented for use by experienced engineers and architects. Design standards are established for Class A (Bridge), Class B (Building), and Class C (Special) structures. A discussion of special considerations such as concrete protection, types of aggregate joints, climatic influences, shear effects, design criteria for slabs-on-grade, and capacities of anchor bolts is included.

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FOREWORD

This design manual is one of a series developed from an evaluation of facilities in the shore establishment, from surveys of the availability of new materials and construction methods, and from selection of the best design practices of the Naval Facilities Engineering Command, other Government agencies, and the private sector. This manual uses to the maximum extent feasible, national professional society, association, and institute standards in accordance with NAVFACENGCOM policy. Deviations from these criteria should not be made without prior approval of NAVFACENGCOM Headquarters (Code 04).

Design cannot remain static any more than can the naval functions it serves or the technologies it uses. Accordingly, recommendations for improvement are encouraged from within the Navy and from the private sector and should be furnished to NAVFACENGCOM Headquarters, Code 04. As the design manuals are revised, they are being restructured. A chapter or a combination of chapters will be issued as a separate design manual for ready reference to specific criteria.

This publication is certified as an official publication of the Naval Facilities Engineering Command and has been reviewed and approved in accordance with SECNAVINST 5600.16.



D. G. Iselin
Rear Admiral, CEC, U.S. Navy
Commander
Naval Facilities Engineering Command

STRUCTURAL ENGINEERING DESIGN MANUALS

<u>New DM Number</u>	<u>Superseded Chapter in Basic DM</u>	<u>Subject</u>
2.1	-	General Requirements
2.2	1	Loads
2.3	2	Steel Structures
2.4	3	Concrete Structures
2.5	4	Timber Structures
2.6	5, 6, 7, 8	Aluminum Structures Masonry Structures Composite Structures Other Structural Materials
2.7	-	Snow Loads (Tri-Service)

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Section 1. SCOPE AND RELATED CRITERIA

1. SCOPE. This manual prescribes criteria for the design of concrete structures, except floating structures and pavements.
2. CANCELLATIONS. This manual, NAVFAC DM-2.4, Concrete Structures, cancels and supersedes Chapter 3 of Structural Engineering, NAVFAC DM-2, of October 1970, and Changes 1 and 2.
3. RELATED CRITERIA. Certain criteria related to the design of concrete structures appear in other manuals in the design manual series and in other sources, as follows:

<u>Subject</u>	<u>Source</u>
General Requirements Service Classification	NAVFAC DM-2.1
Soil Mechanics, Foundations, Earth Structures Foundations	NAVFAC DM-7
Fire Protection Engineering Fire Protection	NAVFAC DM-8
Cold Regions Engineering Concrete in Cold Regions	NAVFAC DM-9
Liquid Fueling and Dispensing Facilities . . Underground Concrete Storage Tanks	NAVFAC DM-22
Bridges	Standard Specifica- tion for Highway Bridges, AASHTO Standard Manual for Railway Engineering, AREA Standard.
Building Code Requirements for Reinforced Concrete Reinforced Concrete	ACI Standard 318
Plain Concrete	ACI Standard 322
Chimneys	ACI Standard 307
General Criteria for Waterfront Construction Exposure to Seawater	NAVFAC DM-25.7

4. CONCRETE STRENGTH. Recommended concrete strengths for various types of structures and various exposures are listed in Table 1.

TABLE 1
Recommended Concrete Strengths

Application	Recommended Strength*
1. Mass concrete, not exposed to atmospheric conditions or other deteriorating agents, where mass rather than strength is principal condition.	2000 psi (13.79 MPa),** or less
2. Fills.	"
3. Encasements for utility lines and ducts.	2500 psi (17.24 MPa)
4. Concrete exposed to frost action where 2000 psi concrete would otherwise be used.	"
5. Foundation walls and footings.	3000 psi (20.68 MPa)
6. Drainage and utility structures.	"
7. Mass concrete exposed to sea water or other deteriorating agents.	"
8. Cast-in-place concrete piles for shore use.	"
9. Retaining walls subject to ordinary exposure conditions.	"
10. Reinforced concrete buildings and similar structures.	3000 to 3500 psi (20.68 to 24.13 MPa)
11. Architectural precast members.	3000 to 4000 psi (20.68 to 27.58 MPa)
12. Structures to contain noncorrosive fluids such as tanks and reservoirs.	3500 to 4000 psi (24.13 to 27.58 MPa)
13. Waterfront structures on fresh water.	3500 (24.13 MPa)
14. Reinforced concrete structures over sea water which are sufficiently elevated so that they are not ordinarily wetted by salt water.	"
15. Walls subjected to severe exposure conditions.	3500 to 4000 psi (24.13 to 27.58 MPa)
16. Concrete deposited under water (tremie concrete).	"
17. Mass concrete exposed to sea water from 3 ft below low water to 3 ft above high water or above normal action.	3500 psi (24.13 MPa)
18. Columns in multistory buildings carrying heavy loads.	4000 psi (27.58 MPa)